

General

Guideline Title

Practice advisory: the utility of EEG theta/beta power ratio in ADHD diagnosis: report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology.

Bibliographic Source(s)

Gloss D, Varma JK, Pringsheim T, Nuwer MR. Practice advisory: the utility of EEG theta/beta power ratio in ADHD diagnosis: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. *Neurology*. 2016 Nov 29;87(22):2375-9. [17 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Definitions of the levels of the recommendations (Level A-U/R) and classification of the evidence (Class I-IV) are provided at the end of the "Major Recommendations" field.

Practice Recommendations

Rationale

Diagnosis with Clinical Examination and Electroencephalogram (EEG) Testing

The evidence for the utility of EEG theta/beta power ratio to augment a clinician's judgment when he or she is diagnosing possible attention-deficit/hyperactivity disorder (ADHD) is not strong enough to make a recommendation. A test must have a demonstrated advantage over the existing common clinical practice to supersede that practice. A research study is the proper setting in which to demonstrate that the current clinical practice of using a clinical examination in evaluation for ADHD can be improved on.

Recommendation

Clinicians should inform patients with suspected ADHD and their families that the EEG theta/beta power should not be used to confirm an ADHD diagnosis or to support further testing after a clinical evaluation, unless such diagnostic assessments take place within the limits of a research study (Level R).

Note: Level R recommendations are ones that "the guideline authors assert should be applied only in research settings."

Rationale

Accuracy of EEG Theta/Beta Power Ratio

The authors downgraded their confidence in the evidence to moderate because of significant problems with generalizability (see appendix e-6 in the data supplement [see the "Availability of Companion Documents" field]). Physicians pledge to do no harm when they take the Hippocratic Oath. There is a risk for significant harm to people misdiagnosed with ADHD because of an unacceptably high false-positive EEG result. Because of this risk of harm, the combination of theta/beta power ratio and frontal beta power should not be used in place of a standard clinical examination.

Recommendations

Clinicians should inform patients with suspected ADHD and their families that the combination of EEG theta/beta power ratio and frontal beta power should not replace a standard clinical evaluation (Level B). There is a risk for significant harm to patients of being misdiagnosed with ADHD because of the unacceptably high false-positive diagnostic rate of EEG theta/beta power ratio and frontal beta power (Level B).

Definitions

American Academy of Neurology Rules for Classification of Evidence for Risk of Bias

Diagnostic Scheme

Class I

A cohort study with prospective data collection of a broad spectrum of persons with the suspected condition, using an acceptable reference standard for case definition. The diagnostic test is objective or performed and interpreted without knowledge of the patient's clinical status. Study results allow calculation of measures of diagnostic accuracy.

Class II

A case-control study of a broad spectrum of persons with the condition established by an acceptable reference standard compared to a broad spectrum of controls or a cohort study where a broad spectrum of persons with the suspected condition where the data was collected retrospectively. The diagnostic test is objective or performed and interpreted without knowledge of disease status. Study results allow calculation of measures of diagnostic accuracy.

Class III

A case-control study or cohort study where either persons with the condition or controls are of a narrow spectrum. The condition is established by an acceptable reference standard. The reference standard and diagnostic test are objective or performed and interpreted by different observers. Study results allow calculation of measures of diagnostic accuracy.

Class IV

Studies not meeting Class I, II, or III criteria, including consensus, expert opinion, or a case report.

Assigning a Level of Strength to the Recommendation

When there is sufficient evidence to support an inference for the use of an intervention (i.e., the balance of benefits and harms favors the intervention), the author panel assigns one of three recommendation designations: A, B, or C. Each designation corresponds to a helping verb that denotes the level of strength of the recommendation. Level A is the strongest recommendation level and is denoted by the use of the helping verb *must*. *Must* recommendations are rare, as they are based on high confidence in the evidence and require both a high magnitude of benefit and low risk. Level B corresponds to the helping verb *should*. *Should* recommendations tend to be more common, as the requirements are less stringent but still based on the evidence and benefit-risk profile. Finally, Level C corresponds to the helping verb *may* or *might*. *May* and *might* recommendations represent the lowest allowable recommendation level the American Academy of Neurology (AAN) considers useful within the scope of clinical practice and can accommodate the highest degree of practice variation.

Level A denotes a practice recommendation that "must" be done. In almost all circumstances, adherence to the recommendation will improve health-related outcomes. A Level B indicates a recommendation that "should" be done. In most circumstances, adherence to the recommendation will likely improve health-related outcomes. A Level C represents a recommendation that "might" be done. In some circumstances, adherence to the recommendation might improve health-related outcomes.

When there is insufficient evidence to support an inference for the use of an intervention (i.e., the balance of benefits and harms is unknown) a Level U or Level R designation is appropriate.

A Level U indicates that the available evidence is insufficient to support or refute the efficacy of an intervention. A Level R is assigned when the balance of benefits and harms is unknown and the intervention is known to be expensive or have important risks. A Level R designates that the intervention should not be used outside of a research setting. Non-evidence-based factors that need to be transparently and systematically considered when formulating recommendations include the following:

- The relative value of the benefit as compared with the risk; this is derived from consideration of:
 - The importance to patients of the health related-outcomes (both benefits and harms)
 - The size of the intervention's effect
 - The risk of harm of the intervention (i.e., tolerability and safety)
- The feasibility of complying with the intervention (e.g., the intervention's availability)
- The cost of the intervention
- The expected variation in patient preferences relative to the risks, burdens, and benefits of the intervention

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Attention-deficit/hyperactivity disorder (ADHD)

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Neurology

Pediatrics

Intended Users

Physicians

Guideline Objective(s)

- To evaluate the evidence for electroencephalogram (EEG) theta/beta power ratio for diagnosing, or helping to diagnose, attention-deficit/hyperactivity disorder (ADHD)
- To examine the published evidence to determine whether quantitative EEG measures have utility in the diagnosis of ADHD and to make practice recommendations based on the evidence
- To answer the following questions:
 - For patients with ADHD, does the combination of a clinical examination and an examination of the EEG theta/beta power ratio increase diagnostic certainty compared with clinical examination alone?

- For patients with a possible but uncertain diagnosis of ADHD, how accurately does the EEG theta/beta power ratio identify patients with ADHD compared with a clinical examination?

Target Population

Patients with a diagnosis of attention-deficit/hyperactivity disorder (ADHD) or suspected ADHD

Interventions and Practices Considered

1. Electroencephalogram (EEG) theta/beta power ratio and frontal beta power (not recommended)
2. Standard clinical examination

Major Outcomes Considered

- Accuracy of diagnosis
- Harms associated with misdiagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Searches of Unpublished Data

Description of Methods Used to Collect/Select the Evidence

The authors performed a comprehensive literature search of the MEDLINE, EMBASE, and Science Citation Index databases, without time constraints, using the keywords "ADHD," "EEG," "theta/beta ratio," and their associated variants. The initial literature search was performed on October 13 and 14, 2013, and was updated on March 12, 2015, with one final check on May 10, 2015. Appendix e-4 in the online Data Supplement (see the "Availability of Companion Documents" field) presents the complete search strategy. The search yielded 959 abstracts, and each abstract was reviewed for relevance by 2 authors working independently of each other. Articles were considered for inclusion if they (1) examined the theta/beta power ratio in patients with attention-deficit/hyperactivity disorder (ADHD) and (2) could address either of the clinical questions. Articles were excluded if they (1) enrolled fewer than 10 participants, which would have resulted in too great a risk of bias; (2) were rated as Class IV by American Academy of Neurology (AAN) criteria (including reviews and meta-analyses; see the "Rating Scheme for the Strength of the Evidence" field for classification of evidence scheme for diagnostic articles); or (3) studied ADHD as determined by clinical examination criteria other than those from the *Diagnostic and Statistical Manual of Mental Disorders, 5th edition* (DSM-5) and its earlier variants. An additional criterion for exclusion was information not published in the peer-reviewed literature, with one exception. Data were provided to the U.S. Food and Drug Administration (FDA) for the Neuropsychiatric EEG-Based ADHD Assessment Aid (NEBA), a portion of which the authors obtained in self-published form. Additional information about the trial was found in the de novo FDA application. In this practice advisory, the authors include in their assessment both the published data and the data from the de novo FDA application.

Number of Source Documents

Question 1

A single Class III study addressed this question.

Question 2

A total of 32 articles addressed this question; 30 were rated as Class IV and 2 were rated as Class I.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

American Academy of Neurology (AAN) Rules for Classification of Evidence for Risk of Bias

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Class IV

Studies not meeting Class I, II, or III criteria, including consensus, expert opinion, or a case report.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

After reviewing the selected full-text articles, the authors classified each according to the American Academy of Neurology's (AAN's) evidence-based methodology (see the "Rating Scheme for the Strength of the Evidence" field). The authors' confidence in the evidence was determined by factors derived from the AAN's modified Grading of Recommendations Assessment, Development and Evaluation approach (see the "Rating Scheme for the Strength of the Evidence" and the "Rating Scheme for the Strength of the Recommendations" fields in this summary and appendices e-6 and e-7 in the online Data Supplement [see the "Availability of Companion Documents" field]).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

In October 2013, the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology (AAN) convened a panel of experts to develop this practice advisory (see appendix e-2 and e-3 in the online Data Supplement [see the "Availability of Companion Documents" field]). The panel followed the methods described in the 2011 edition of the AAN's guideline development process manual, as amended, including the process for developing practice advisories.

The guideline authors based the strength of the recommendations on results from a modified Delphi process to determine the weight of several

factors, including the evidence rating, cost considerations, risks, and feasibility (see appendix e-8 in the online Data Supplement [see the "Availability of Companion Documents" field]).

Refer to appendix e-7 in the Data Supplement for steps and rules for formulating recommendations.

Rating Scheme for the Strength of the Recommendations

Assigning a Level of Strength to the Recommendation

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When there is insufficient evidence to support an inference for the use of an intervention (i.e., the balance of benefits and harms is unknown) a Level U or Level R designation is appropriate.

A Level U indicates that the available evidence is insufficient to support or refute the efficacy of an intervention. A Level R is assigned when the balance of benefits and harms is unknown and the intervention is known to be expensive or have important risks. A Level R designates that the intervention should not be used outside of a research setting. Non-evidence-based factors that need to be transparently and systematically considered when formulating recommendations include the following:

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- The feasibility of complying with the intervention (e.g., the intervention's availability)
- The cost of the intervention
- The expected variation in patient preferences relative to the risks, burdens, and benefits of the intervention

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

Drafts of the practice advisory have been reviewed by at least 3 American Academy of Neurology (AAN) committees, a network of neurologists, *Neurology*® peer reviewers, and representatives from related fields.

The practice advisory was approved by the Guideline Development, Dissemination, and Implementation Subcommittee on April 13, 2015; by the

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Increased diagnostic certainty in patients with attention-deficit/hyperactivity disorder (ADHD)
- More accurate identification of patients with ADHD

Potential Harms

There is a risk for significant harm to patients of being misdiagnosed with attention-deficit/hyperactivity disorder (ADHD) because of the unacceptably high false-positive diagnostic rate of electroencephalogram (EEG) theta/beta power ratio and frontal beta power.

Qualifying Statements

Qualifying Statements

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Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Patient Resources

Quick Reference Guides/Physician Guides

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Living with Illness

IOM Domain

Effectiveness

Patient-centeredness

Safety

Identifying Information and Availability

Bibliographic Source(s)

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Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2016 Nov 29

Guideline Developer(s)

American Academy of Neurology - Medical Specialty Society

Source(s) of Funding

This practice advisory was developed with financial support from the American Academy of Neurology (AAN). Authors who serve as AAN subcommittee members or methodologists were reimbursed by the AAN for expenses related to travel to subcommittee meetings where drafts of manuscripts were reviewed.

Guideline Committee

Composition of Group That Authored the Guideline

Guideline Authors: David Gloss, MD; Jay K. Varma, MD; Tamara Pringsheim, MD; Marc R. Nuwer, MD, PhD

Guideline Development, Dissemination, and Implementation (GDDI) Subcommittee Members: Cynthia Harden, MD (*Chair*); Steven R. Messé, MD (*Co-Vice-Chair*); Sonja Potrebic, MD, PhD (*Co-Vice-Chair*); Eric J. Ashman, MD; Richard L. Barbano, MD, PhD; Brian Callaghan, MD; Jane Chan, MD; Diane Donley, MD; Richard M. Dubinsky, MD, MPH; Terry Fife, MD; Jeffrey Fletcher, MD; Michael Haboubi, DO; John J. Halperin, MD; Yolanda Holler, MD; Andres M. Kanner, MD; Annette M. Langer-Gould, MD, PhD; Jason Lazarou, MD; Nicole Licking, DO; David Michelson, MD; Pushpa Narayanaswami, MBBS, DM; Maryam Oskoui, MD; Richard Popwell, Jr., MD; Tamara Pringsheim, MD; Alejandro A. Rabinstein, MD; Alexander Rae-Grant, MD; Anant Shenoy, MD; Kevin Sheth, MD; Kelly Sullivan, PhD; Theresa A. Zesiewicz, MD; Jonathan P. Hosey, MD (*Ex-Officio*); Stephen Ashwal, MD (*Ex-Officio*); Deborah Hirtz, MD; Jacqueline French, MD (*Guideline Process Historian*)

Financial Disclosures/Conflicts of Interest

Conflict of Interest

The American Academy of Neurology (AAN) is committed to producing independent, critical, and truthful practice advisories. Significant efforts are made to minimize the potential for conflicts of interest to influence the recommendations of this practice advisory. To the extent possible, the AAN keeps separate those who have a financial stake in the success or failure of the products appraised in the practice advisories and the developers of these documents. Conflict of interest forms were obtained from all authors and reviewed by an oversight committee prior to project initiation. AAN limits the participation of authors with substantial conflicts of interest. The AAN forbids commercial participation in, or funding of, practice advisory projects. Drafts of the practice advisory have been reviewed by at least 3 AAN committees, a network of neurologists, *Neurology*® peer reviewers, and representatives from related fields. The AAN Guideline Author Conflict of Interest Policy can be viewed at www.aan.com . For complete information on this process, access the 2011 AAN process manual.

Disclosure

D. Gloss is an evidence-based medicine consultant for the American Academy of Neurology. J. Varma reports no disclosures relevant to the manuscript. T. Pringsheim has received a research grant from Shire Canada. M. Nuwer has served as an expert in legal proceedings related to QEEG. Go to Neurology.org for full disclosures.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

A list of American Academy of Neurology (AAN) guidelines, along with a link to this guideline, is available from the [AAN Web site](#) .

Availability of Companion Documents

The following are available:

- Practice advisory: the utility of EEG theta/beta power ratio in ADHD diagnosis: report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. Data supplement. St. Paul (MN): American Academy of Neurology; 2016. 16 p. Available from the [Neurology Journal Web site](#) .
- Practice advisory: the utility of EEG theta/beta power ratio in ADHD diagnosis: report of the Guideline Development, Dissemination, and

Implementation Subcommittee of the American Academy of Neurology. Presentation slides. Available from the [American Academy of Neurology \(AAN\) Web site](#) .

- Practice advisory: the utility of EEG theta/beta power ratio in ADHD diagnosis. Summary of practice advisory for clinicians. St. Paul (MN): American Academy of Neurology; 2016. 2 p. Available from the [AAN Web site](#) .
- American Academy of Neurology (AAN). Clinical Practice Guideline Process Manual, 2011 Ed. St. Paul (MN): American Academy of Neurology. Available from the [AAN Web site](#) .

Patient Resources

The following is available:

- QEEG in ADHD diagnosis. Summary of practice advisory for patients and their families. St. Paul (MN): American Academy of Neurology; 2016. 2 p. Available from the [American Academy of Neurology \(AAN\) Web site](#) .

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

NGC Status

This NGC summary was completed by ECRI Institute on March 14, 2017. The information was verified by the guideline developer on April 17, 2017.

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